PCT Art. 34

AMENDMENT (Translation)

(Amendment under Art. 11)

To: Commissioner, Patent Office

(To: Examiner of the Patent Office

Mr. Masahiro ISHIHARA)

1. Identification of the International Application

PCT/JP99/00822

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4. Date of Notification December 14, 1999 (Date of Mailing)

5. Scope of Amendments

Specification and claims

6. Contents of Amendments

See attached sheets.

(1) On page 6 lines 9-10, page 6 line 25 to page 7 line 1, page 7 lines 14-15, page 9 lines 17-18, page 10 lines 10-11, page 10 line 25 to page 11 line 1 in the specification, please change "this is compressed and molded, and then preliminarily sintered to form a sintered electrode" to – this is compressed and molded, and then burned at a temperature at which the ferrous-family or non-ferrous metal powder starts to elute to form an electrode–.

(2) On page 8 lines 6, 11, 16, 20, page 9 lines 1, 7, 18, page 10 line 11, page 11 lines 1, 20, page 12 lines 1, 6-7, 13, 16, 24, page 13 lines 3, 10, 14, page 14 lines 15-16, 18, 20, page 15 lines 2-3, 5, 7, 14-15, 17, 19, page 16 line 24, page 17 lines 1, 3, 11, 13, 15, 23, 25, page 18 line 2, page 19 lines 17-18, 23, page 20 lines 19, page 21 lines 20-21, page 22 lines 15-16, 21, page 24 line 2, page 26 lines 11, 16-17, 25, and page 28 lines 6-7, 14, "sintered electrode" to –discharge processing electrode–.

(3) On page 21 line 17 of the specification, please change "sintered electrode" to –electrode–.

(4) On page 21 line 15-16 and page 21 line 25 to page 22

line 1 of the specification, please change "sintering temperature" to -burning temperature-.

(5) On page 21 line 4 of the specification, please change "preliminary sintering temperature" to -burning temperature in a preliminary sintering process-.

(6) On page 30 lines 12-13, page 31 lines 8-9, page 32 lines 1-2, page 34 lines 3-4, page 34 line 25 to page 35 line 1, page 35 lines 20-21, of claims, please change "this is compressed and molded, and then preliminarily sintered to form a sintered electrode" to -this is compressed and molded, and then burned at a temperature at which the ferrous-family or non-ferrous metal powder starts to elute to form an electrode-.

(7) On page 32 lines 18, 22, page 33 lines 1, 4, 9, 14, page 34 line 4, page 35 lines 1, 21, page 36 lines 14-15, 19-20, 24-25, page 37 lines 5, 8, 15, 18, 25, page 38 line 3 of claims, please change "sintered electrode" to -discharge processing electrode-.

7. List of attached documents

Page 6 to page 28 of the specification and pages 30 to 38 of claims.

parts such as metal molds, tools and machine essential parts.

In the discharging surface treatment method according to a first aspect of this invention, a powder that is formed by a simple substance or a combination of a plurality of carbides of metals belonging to the IVa, Va and VIa families in the Periodic Table is mixed ferrous-family metal powder or non-ferrous metal powder having the same composition as the treatment target as a simple substance or a combination of a plurality of metals, and this is compressed and molded, and then burned at a temperature at which the ferrous-family or non-ferrous metal powder starts to elute to form an electrode serving as a discharge processing electrode, and the electrical conditions at the time when the base member of the treatment target is directly subjected to a discharging surface treatment and the electrical conditions at the time when a hard coat film that has been formed is subjected to a discharging surface treatment are altered according to the characteristics of the treatment target material.

In the discharging surface treatment method according to a second aspect of this invention, a powder that is formed by a simple substance or a combination of a plurality of carbides of metals belonging to the IVa, Va and VIa families in the Periodic Table is mixed ferrous-family metal powder or non-ferrous metal powder having the same composition as the treatment target as a simple substance or a combination

of a plurality of metals, and this is compressed and molded, and then burned at a temperature at which the ferrous-family or non-ferrous metal powder starts to elute to form an electrode serving as a discharge processing electrode, and the electrical conditions at the time when a hard coat film that has been formed is subjected to a discharging surface treatment are altered at least once according to the characteristics of the treatment target material.

In the discharging surface treatment method according to a third aspect of this invention, a powder that is formed by a simple substance or a combination of a plurality of carbides of metals belonging to the IVa, Va and VIa families in the Periodic Table is mixed ferrous-family metal powder or non-ferrous metal powder having the same composition as the treatment target as a simple substance or a combination of a plurality of metals, and this is compressed and molded, and then burned at a temperature at which the ferrous-family or non-ferrous metal powder starts to elute to form an electrode serving as a discharge processing electrode, and the electrical conditions at the time when the base member of the treatment target is directly subjected to a discharging surface treatment and the electrical conditions at the time when a hard coat film that has been formed is subjected to a discharging surface treatment are altered according to the characteristics of the treatment target material, while

the electrical conditions at the time when the hard coat film that has been formed is subjected to a discharging surface treatment are altered at least once according to the characteristics of the treatment target material.

In the discharging surface treatment method according to a fourth aspect of this invention, in the configuration according to the first aspect of this invention, it is preferable that an inert gas is interpolated between the discharge processing electrode and the treatment target.

In the discharging surface treatment method according to a fifth aspect of this invention, in the configuration according to the second aspect of this invention, it is preferable that an inert gas is interpolated between the discharge processing electrode and the treatment target.

In the discharging surface treatment method according to a sixth aspect of this invention, in the configuration according to the third aspect of this invention, it is preferable that an inert gas is interpolated between the discharge processing electrode and the treatment target.

In the discharging surface treatment method according to a seventh aspect of this invention, in the configuration according to the first aspect of this invention, it is preferable that the discharge processing electrode is allowed to scan the treatment target so that the hard coat film is formed on the surface of the treatment target.

In the discharging surface treatment method according to a eighth aspect of this invention, in the configuration according to the second aspect of this invention, it is preferable that the discharge processing electrode is allowed to scan the treatment target so that the hard coat film is formed on the surface of the treatment target.

In the discharging surface treatment method according to a ninth aspect of this invention, in the configuration according to the third aspect of this invention, it is preferable that the discharge processing electrode is allowed to scan the treatment target so that the hard coat film is formed on the surface of the treatment target.

In the discharging surface treatment device according to a tenth aspect of this invention, a powder that is formed by a simple substance or a combination of a plurality of carbides of metals belonging to the IVa, Va and VIa families in the Periodic Table is mixed ferrous-family metal powder or non-ferrous metal powder having the same composition as the treatment target as a simple substance or a combination of a plurality of metals, and this is compressed and molded, and then burned at a temperature at which the ferrous-family or non-ferrous metal powder starts to elute to form an electrode serving as a discharge processing electrode. Moreover, the above-mentioned device is provided with a switching unit which alters the electrical conditions at

the time when the base member of the treatment target is directly subjected to a discharging surface treatment and the electrical conditions at the time when a hard coat film that has been formed is subjected to a discharging surface treatment according to the characteristics of the treatment target material.

In the discharging surface treatment device according to an eleventh aspect of this invention, a powder that is formed by a simple substance or a combination of a plurality of carbides of metals belonging to the IVa, Va and VIa families in the Periodic Table is mixed ferrous-family metal powder or non-ferrous metal powder having the same composition as the treatment target as a simple substance or a combination of a plurality of metals, and this is compressed and molded, and then burned at a temperature at which the ferrous-family or non-ferrous metal powder starts to elute to form an electrode serving as a discharge processing electrode. Moreover, the device is provided with a switching unit which alters the electrical conditions at the time when a hard coat film that has been formed is subjected to a discharging surface treatment at least once according to the characteristics of the treatment target material.

In the discharging surface treatment device according to a twelfth aspect of this invention, a powder that is formed by a simple substance or a combination of a plurality of

carbides of metals belonging to the IVa, Va and VIa families in the Periodic Table is mixed ferrous-family metal powder or non-ferrous metal powder having the same composition as the treatment target as a simple substance or a combination of a plurality of metals, and this is compressed and molded, and then burned at a temperature at which the ferrous-family or non-ferrous metal powder starts to elute to form an electrode serving as a discharge processing electrode. Moreover, the above-mentioned device is provided with a first switching unit which alters the electrical conditions at the time when the base member of the treatment target is directly subjected to a discharging surface treatment and the electrical conditions at the time when a hard coat film that has been formed is subjected to a discharging surface treatment according to the characteristics of the treatment target material, and a second switching unit which alters the electrical conditions at the time when the hard coat film that has been formed is subjected to a discharging surface treatment at least once according to the characteristics of the treatment target material.

In the discharging surface treatment device according to a thirteenth aspect of this invention, in the configuration according to the tenth aspect of this invention, it is preferable that an inert-gas supplying unit is installed so as to interpolate an inert gas between the discharge

processing electrode and the treatment target.

In the discharging surface treatment device according to a fourteenth aspect of this invention, in the configuration according to the eleventh aspect of this invention, it is preferable that an inert-gas supplying unit is installed so as to interpolate an inert gas between the discharge processing electrode and the treatment target.

In the discharging surface treatment device according to a fifteenth aspect of this invention, in the configuration according to the twelfth aspect of this invention, it is preferable that an inert-gas supplying unit is installed so as to interpolate an inert gas between the discharge processing electrode and the treatment target.

In the discharging surface treatment device according to a sixteenth aspect of this invention, in the configuration according to the tenth aspect of this invention, it is preferable that an X-axis driving device, a Y-axis driving device and a Z-axis driving device, which relatively shift the discharge processing electrode and the treatment target in the X-direction, Y-direction and Z-direction, are installed so that the X-axis driving device, the Y-axis driving device and the Z-axis driving device allow the discharge processing electrode to scan the treatment target to form the hard coat film on the surface of the treatment target.

In the discharging surface treatment device according to a seventeenth aspect of this invention, in the configuration according to the eleventh aspect of this invention, it is preferable that an X-axis driving device, a Y-axis driving device and a Z-axis driving device, which relatively shift the discharge processing electrode and the treatment target in the X-direction, Y-direction and Z-direction, are installed so that the X-axis driving device, the Y-axis driving device and the Z-axis driving device allow the discharge processing electrode to scan the treatment target to form the hard coat film on the surface of the treatment target.

In the discharging surface treatment device according to a eighteenth aspect of this invention, in the configuration according to the twelfth aspect of this invention, it is preferable that an X-axis driving device, a Y-axis driving device and a Z-axis driving device, which relatively shift the discharge processing electrode and the treatment target in the X-direction, Y-direction and Z-direction, are installed so that the X-axis driving device, the Y-axis driving device and the Z-axis driving device allow the discharge processing electrode to scan the treatment target to form the hard coat film on the surface of the treatment target.

Since the present invention has the above-mentioned

arrangement, the following effects are obtained.

The discharging surface treatment method according to any one of the first to third aspects makes it possible to easily form an electrode and also to form a hard coat film having high adhesion to the treatment target efficiently. Therefore, the discharging surface treatment method is applicable to various machine parts such as molds, tools and machine constituent parts. Moreover, the hard coat film is allowed to deposit on the treatment target with an area virtually equal to the area of the electrode, thereby making it possible to eliminate the need of a masking treatment.

The discharging surface treatment method according to the fourth aspect has such an effect in addition to the effects of the first aspect that the structure is simplified.

The discharging surface treatment method according to the fifth aspect has such an effect in addition to the effects of the second aspect that the structure is simplified.

The discharging surface treatment method according to the sixth aspect has such an effect in addition to the effects of the third aspect that the structure is simplified.

In addition to the effects of the first aspect, the discharging surface treatment method according to the seventh aspect makes it possible to use a small-size discharge processing electrode, and the process is carried out with this electrode being allowed to scan. Therefore, it is not

necessary to use a large-size discharge processing electrode having a specific shape, and it is possible to form a hard coat film with the small-size discharge processing electrode being allowed to scan on the entire curved face of the treatment target, such as a mold, having a three-dimensional free curved face, so as to have a uniform thickness over the entire area or a varied film thickness, if necessary.

In addition to the effects of the second aspect, the discharging surface treatment method according to the eighth aspect makes it possible to use a small-size discharge processing electrode, and the process is carried out with this electrode being allowed to scan. Therefore, it is not necessary to use a large-size discharge processing electrode having a specific shape, and it is possible to form a hard coat film with the small-size discharge processing electrode being allowed to scan on the entire curved face of the treatment target, such as a mold, having a three-dimensional free curved face, so as to have a uniform thickness over the entire area or a varied film thickness, if necessary.

In addition to the effects of the third aspect, the discharging surface treatment method according to the ninth aspect makes it possible to use a small-size discharge processing electrode, and the process is carried out with this electrode being allowed to scan. Therefore, it is not necessary to use a large-size discharge processing electrode

having a specific shape, and it is possible to form a hard coat film with the small-size discharge processing electrode being allowed to scan on the entire curved face of the treatment target, such as a mold, having a three-dimensional free curved face, so as to have a uniform thickness over the entire area or a varied film thickness, if necessary.

The discharging surface treatment device according to any one of the tenth to twelfth aspects makes it possible to easily form an electrode and also to form a hard coat film having high adhesion to the treatment target efficiently. Therefore, the discharging surface treatment method is applicable to various machine parts such as molds, tools and machine constituent parts. Moreover, the hard coat film is allowed to deposit on the treatment target with an area virtually equal to the area of the electrode, thereby making it possible to eliminate the need of a masking treatment.

The discharging surface treatment device according to the thirteenth aspect has such an effect in addition to the effects of the tenth aspect that the structure is simplified.

The discharging surface treatment device according to the fourteenth aspect has such an effect in addition to the effects of the eleventh aspect that the structure is simplified.

The discharging surface treatment device according to the fifteenth aspect has such an effect in addition to the

effects of the twelfth aspect that the structure is simplified.

In addition to the effects of the tenth aspect, the discharging surface treatment device according to the sixteenth aspect makes it possible to use a small-size discharge processing electrode, and the process is carried out with this electrode being allowed to scan. Therefore, it is not necessary to use a large-size discharge processing electrode having a specific shape, and it is possible to form a hard coat film with the small-size discharge processing electrode being allowed to scan on the entire curved face of the treatment target, such as a mold, having a three-dimensional free curved face, so as to have a uniform thickness over the entire area or a varied film thickness, if necessary.

In addition to the effects of the eleventh aspect, the discharging surface treatment method according to the seventeenth aspect makes it possible to use a small-size discharge processing electrode, and the process is carried out with this electrode being allowed to scan. Therefore, it is not necessary to use a large-size discharge processing electrode having a specific shape, and it is possible to form a hard coat film with the small-size discharge processing electrode being allowed to scan on the entire curved face of the treatment target, such as a mold, having a

three-dimensional free curved face, so as to have a uniform thickness over the entire area or a varied film thickness, if necessary.

In addition to the effects of the twelfth aspect, the discharging surface treatment method according to the eighteenth aspect makes it possible to use a small-size discharge processing electrode, and the process is carried out with this electrode being allowed to scan. Therefore, it is not necessary to use a large-size discharge processing electrode having a specific shape, and it is possible to form a hard coat film with the small-size discharge processing electrode being allowed to scan on the entire curved face of the treatment target, such as a mold, having a three-dimensional free curved face, so as to have a uniform thickness over the entire area or a varied film thickness, if necessary.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a structural drawing that shows a discharging surface treatment method and a device for such a method according to a first embodiment of the present invention; Fig. 2 is a drawing that shows a state in which a hard coat film is deposited by continuous discharging in the discharging surface treatment method and the device thereof according to the first embodiment the present invention;

Fig. 3 is a drawing that shows a state in which a thick film is formed in the discharging surface treatment method and the device thereof according to the first embodiment of the present invention; Fig. 4 is a drawing that shows a switching unit for altering electrical conditions in the discharging surface treatment method and the device thereof according to the first embodiment the present invention; Fig. 5 is a structural drawing that shows a discharging surface treatment method and a device for such a method according to a second embodiment of the present invention; Fig. 6 is a structural drawing that shows a discharging surface treatment method and a device for such a method according to a third embodiment of the present invention; and Fig. 7 is a structural drawing that shows a conventional surface treatment method.

BEST MODE FOR CARRYING OUT THE INVENTION

FIRST EMBODIMENT

Fig. 1 is a structural drawing that shows a discharging surface treatment method and a device for such a method according to a first embodiment of the present invention. Reference number 2 represents a treatment target, and reference number 3 represents a processing vessel. Reference number 4 represents a processing fluid, such as insulating oil or water. Reference number 10 represents a

shifting motor, and reference number 11 represents a shifting thread. Reference number 12 represents a discharge processing electrode, and reference number 13 represents a hard coat film formed on the treatment target 2. Reference number 14 represents a control device, provided with a power supply, for controlling a current and a voltage. The shifting motor 10, controlled by a controlling system not shown, is designed so that the discharge processing electrode 12 is shifted toward the treatment target 2 in a desired control mode, such as a servo-shifting mode and a constant-shifting mode, through the shifting thread 11.

As mentioned-above, the processing fluid 4 is insulating oil or water. Following advantages are obtained when the insulating oil is used. That is, conventional techniques of discharge processing devices that have been widely used are applicable, as they are, and a comparatively simple structure is available. On the other hand, if water is used, in some cases, hydroxides may be generated simultaneously as the reaction takes place, resulting in a problem when a high-quality coat film is required. However, in the case of the application of a non-electrolytic power supply in a wire discharge processing device that has been widely used at present, the above-mentioned disadvantage is reduced to a minimum so that even water is used as the processing fluid, it becomes possible to form a hard coat

film having virtually the same characteristics as that produced by using an insulating oil as the processing fluid from the viewpoint of practical use.

A method of manufacturing the discharge processing electrode 12 will now be explained. A powder that is formed by a simple substance or a combination of a plurality of carbides of metals belonging to the IVa, Va and VIa families in the Periodic Table (for example, WC, TiC, TaC, etc.) is mixed ferrous-family metal powder such as Fe, Co and Ni, or non-ferrous metal powder having the same composition as the treatment target (for example, Al alloy powder, etc.) as a simple substance or in combination, and this is compressed and molded into a predetermined shape, thereby manufacturing a green compact electrode. Then, this is put into a vacuum furnace, etc., and the temperature inside the furnace is gradually increased so as to harden the green compact electrode to a degree, for example, approximately as hard as chalk so that it has sufficient strength to withstand a mechanical machining process and also is not hardened too much (this process is referred to as "preliminary sintering process"). In this state, the ferrous-family metal such as Co starts to elute to be buried in gaps between carbides, thereby forming a so-called solid solution. In contrast, at contact portions between the carbides, although mutual bonding progresses, the bonding is weak because the sintering

temperature is comparatively low with the result that a main sintering process is not attained. The discharge processing electrode in this state, which has been subjected to the preliminary sintering process, is taken out, and machined and sized to a predetermined shape. Thus, this is used as the discharge processing electrode 12.

The conditions of the above-mentioned preliminary sintering process are different depending on electrode materials. However, this is determined preliminarily through experiments. For example, the sintering temperature is set approximately in the range of 400 to 1100 degree centigrade.

In this case, it is essential not to raise the preliminary sintering temperature to approximately not less than 1100 degree centigrade. The temperatures exceeding this temperature make the electrode too hard, resulting in a problem in which in the next discharging process, the electrode material comes off irregularly due to a thermal impact caused by arc discharging, failing to properly supply discharging between the electrodes, resulting in serious adverse effects to the quality of the coat film formed on the treatment target.

Next, an explanation will be given of a formation method of the hard coat film 13. When an arc discharge is generated intermittently or continuously between the discharge

processing electrode 12 and the treatment target 2, the pole-to-pole gap has a high temperature locally due to arc heat. First, when an arc discharge is generated once, one portion of the electrode material comes off between the poles, and is simultaneously discharged in a powdered state by the thermal impact energy at portions of the discharge processing electrode 12 preliminarily sintered facing the treatment target 2. Since the pole-to-pole gap enters a high-temperature plasma state of not less than several thousands of degree centigrade momentarily, most portions of the electrode material are completely fused. The surface of the treatment target facing the electrode is also heated instantaneously at the generation position of the arc discharge, and fused in the same manner as the electrode material. At this high-temperature state, the fused electrode material and the treatment target are mutually mixed with each other to form an alloy phase between the electrode material and the treatment target on the treatment target. Next, since the processing fluid is located in the pole-to-pole gap and in the vicinity thereof, this is abruptly cooled off, and during a cooling phase from the high-temperature state, an interface reaction between the liquid phase of the ferrous-family metal and the solid phase of the carbides or a solid-solution forming reaction between the solid phases of the carbides instantaneously occurs,

thereby executing a main sintering process in an extremely short time. In this manner, a hard coat film 13 is formed on the treatment target 2. When this process is repeated, the deposition of the coat film progresses as the time elapses, thereby making it possible to form a thick film.

Fig. 2 shows a state in which the hard coat film is depositing due to continuous discharges. It can be clearly seen that the hard coat films, each formed by a single discharge, are allowed to deposit in a folded manner.

Fig. 3 shows a state in which a thick film is formed and a discharge current at this time. WC-Co is used as the discharge processing electrode 12 and a steel plate is used as the treatment target 2. Moreover, Fig. 3(a) shows a case in which a discharge is directly applied to the base member of the treatment target 2, and Fig. 3(b) shows a case in which, after a hard coat film 13 has been formed, a discharge is further applied thereto. Depending on the cases in which a discharge is directly applied to the base member of the treatment target 2 and in which a discharge is applied after the hard coat film 13 has been formed, electrical conditions including the discharge current value Ip, the discharge current pulse width τp and the pause time τr are properly altered so as to fit to the characteristics of the subject material. Moreover, depending on cases, the poles of the electrode are also changed. This is because the base member

and the hard coat film formed later are respectively different in material characteristics and hardness. Therefore, the electrical conditions are altered so as to fit to the characteristics of the subject material depending on the cases in which a discharge is directly applied to the base member and in which a discharge is further applied after the hard coat film has been formed so as to fit to the characteristics of the subject material; consequently, the electrical conditions suitable for the corresponding subject material are adopted so that it becomes possible to carry out the process in a shorter time, and also to form a hard coat film with high adhesion. Such electrical conditions suitable for the respective characteristics of the subject materials are preliminarily determined through experiments, etc., and the control device 14 alters these according to the characteristics of the subject material. For example, the alteration of each of the discharging current value Ip, the discharging current pulse width τp and the pause time τr is carried out by switching operations of switches 15 and 16 and the controlling operations of the switching in the control circuit shown in Fig. 4.

Moreover, the above description has shown a case in which the electrical conditions are altered depending on the cases in which a discharge is directly applied to the base member and in which a discharge is further applied after

the hard coat film has been formed. However, even in the course of formation of a thick, hard coat film, the electrical conditions may be altered according to the characteristics of the subject material.

Moreover, in Fig. 4, two switches are used for the switching operations. However, three or more switches may be used. Moreover, any means that can alter the current, such as a variable resistor for changing a current, may be used.

Moreover, Fig. 3 has exemplified a case in which a steel plate is used as the base member of the treatment target. However, when the base member is made of a cemented carbide, Ti-based materials may be used as the electrode. The current waveform is altered in response to various combinations between such treatment target materials and the electrodes.

SECOND EMBODIMENT

Fig. 5 is a structural drawing that shows a discharging surface treatment method and a device for such a method according to a second embodiment of the present invention. Reference number 2 represents a treatment target, and reference number 12 represents a discharge processing electrode. Reference number 13 represents a hard coat film formed on the treatment target 2. Reference number 14 represents a control device, provided with a power supply, for controlling a current and a voltage. The hard coat film

13 is formed on the surface of the treatment target 2 while the discharge processing electrode 12 and the treatment target 2 are relatively shifted in the X-direction, Y-direction and Z-direction by using an X-axis driving device, a Y-axis driving device and a Z-axis driving device, not shown. For example, when the treatment target 2 is a mold, its surface is not a plane face, and has a three-dimensional shape with complex free curved faces. However, the X-axis driving device, the Y-axis driving device and the Z-axis driving device allow the discharge processing electrode 12 to scan along the free curved face of the mold with the gap being maintained constant or the servo-voltage being maintained constant. In this case, since the electrode is consumed very quickly, a compensating shifting operation is required for compensating for the electrode consumption. Therefore, the movement control of the main axis for supporting the electrode in the Z-axis direction needs to be carried out accurately and quickly. The above-mentioned operations are repeated so that the electrode is allowed to scan all over the curved faces constituting the mold. Thus, it becomes possible to deposit the hard coat film over the entire area uniformly, or with a varied film thickness, if necessary.

Moreover, when a discharge is directly applied to the base member of the treatment target and when a discharge

is further applied after the hard coat film has been formed, or in the course of formation of the thick, hard coat film, the electric conditions are altered so as to fit to the characteristics of the subject treatment material, that is, the electric conditions suitable for the subject treatment material are adopted. Thus, it becomes possible to carry out the process in a shorter time, and also to form a hard coat film with high adhesion.

THIRD EMBODIMENT

Fig. 6 is a structural drawing that shows a discharging surface treatment method and a device for such a method according to a third embodiment of the present invention. This embodiment explains a discharging operation performed in the environment of gas. Reference number 2 represents a treatment target. Reference number 10 represents a shifting motor, and reference number 11 represents is a shifting thread. Reference number 12 represents a discharge processing electrode, and reference number 13 represents a hard coat film formed on the treatment target 2. Reference number 14 represents a control device, provided with a power supply, for controlling a current and a voltage. Reference number 17 represents a gas supply source, and reference number 18 represents a path and 19 is a supply pipe. The gas supply source 17 is connected to the path 18 installed inside the discharge processing electrode 12 through a pipe. While